

THE EFFECTS OF DIET THERAPY, BEHAVIOR MODIFICATION, AND  
EXERCISE ON WEIGHT REDUCTION AND SERUM LIPIDS

by

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A MASTER'S THESIS

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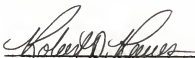
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## TABLE OF CONTENTS

INTRODUCTION . . . . .	1
REVIEW OF LITERATURE . . . . .	5
Causes of Obesity	
Diet Therapy as a Means of Weight Reduction	
Behavior Modification as a Means of Weight Reduction	
Physical Activity and Weight Reduction	
Weight Reduction and Body Composition	
Lean Body Weight and Urinary Creatinine Excretion	
Coronary Heart Disease Risk Factors	
Serum Lipids	
Physical Activity and Serum Lipids	
Body Weight and Serum Lipids	
Blood Pressure and Physical Activity	
Blood Pressure and Body Weight	
Dietary Intake and Serum Lipids	
METHODS AND PROCEDURES . . . . .	19
Subjects	
Preliminary Testing Period	
Post Testing Period	
Experimental Testing Period	
Post Experimental Follow-up	
Statistical Treatment of the Data	
RESULTS AND DISCUSSION . . . . .	26
Body Composition	
Urinary Creatinine Excretion	
Serum Lipids	
Blood Pressure	
Blood Serum Analysis	
Dietary Intake	
SUMMARY AND CONCLUSIONS . . . . .	41
BIBLIOGRAPHY . . . . .	44
APPENDIX . . . . .	50

## INTRODUCTION

Obesity occurs when an excess amount of adipose tissue accumulates on the body mass. This accumulation is a result of an energy imbalance: energy consumed exceeds energy expended. Overeating, a metabolic defect, a lack of physical activity, or a combination of these factors can induce a positive energy balance.

The number of obese individuals in the United States has increased to the point that obesity can be considered a national problem. The United States Public Health Service reports that 25 to 45 percent of the adult American population over 30 years of age is more than 20 percent overweight (1). Data obtained by life insurance companies have shown that life expectancy is increased in individuals who are lighter than average weight and decreased in individuals who are heavier than average weight. This suggests that any excess weight is associated with a detrimental impact on longevity (2).<sup>1</sup>

Statistical evidence has indicated that obese individuals also have a greater propensity for developing diseases such as diabetes mellitus, coronary heart disease, gall bladder disease, and hypertension (3). Because of these relationships and the tendency toward decreased life expectancy, the Select Committee on Nutrition and Human Needs has recommended curtailing energy intake and increasing physical activity for obese individuals (4).

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<sup>1</sup> The terms obesity and overweight are often used synonymously even though they are not really interchangeable. By definition, an obese individual has accumulated an excess amount of adipose tissue on the body mass. An overweight individual is "over" or above average weight. An athlete, who has increased his muscle mass, may be heavier than normal for his height and be considered overweight, even though he may be carrying very little adipose tissue on the body mass.

Until recently, many professionals have taken a pessimistic view of the obese individual's chances of controlling his weight. Results from traditional, dietary approaches to obesity have been discouraging. Stunkard (5) has reported that of 100 obese patients admitted to a nutrition clinic, only 12 percent lost as much as 20 pounds and 28 percent never returned to the clinic. Two years after the end of treatment, only two of the initial 100 patients referred to the clinic had maintained their weight loss.

Stuart (6) was one of the first to successfully use behavioral techniques to help obese individuals change inappropriate eating behaviors. He reported that over a period of one year, 30 percent of the original sample had lost more than 40 pounds and 60 percent lost more than 30 pounds. This approach to obesity is based on the premise that obesity is an inappropriately learned behavior that responds to many environmental cues unrelated to physiological hunger. By using stimulus control techniques which change the antecedents to inappropriate food-related behaviors, an individual can change his eating behavior and the consequences of that behavior.

The importance of body composition to the study of nutrition, exercise performance, and responses to other physical stresses has been recognized. Most of the accepted procedures (fluid volume analysis, whole body isotopic counting, and densitometry) are either time consuming, or they require expensive equipment. Because of the large amount of creatine in muscle tissue and the direct proportionality of body creatine to urinary creatinine excretion, urinary creatinine excretion values have been used to estimate body composition. Although urinary creatinine excretion values have been correlated with lean body mass, the accuracy and consistency with which this method can estimate body composition remains in question.

Risk factors for identifying individuals with a greater propensity for development of coronary heart disease include: depressed high density lipoproteins (7), elevated serum cholesterol levels, hypertension, smoking, physical inactivity, and obesity (8). The risk of developing coronary heart disease is not only proportional to the antecedent level of risk factors, but also the risk increases with the number of risk factors involved (9). The full implications of this statement become disheartening when considering the concomitant factors often associated with obesity: hypertension, high serum cholesterol levels, depressed high density lipoprotein levels, and physical inactivity.

Because of the relationship of obesity to reduced life expectancy, coronary heart disease, and the potential for infringement on personal happiness, a need exists to investigate the effectiveness of behavioral and dietary approaches to weight reduction and the effects of weight reduction and physical activity on body composition, blood pressure, and serum lipids.

The purpose of the present study, conducted jointly by the Department of Foods and Nutrition and the Department of Health, Physical Education and Recreation, was to investigate the effects of four methods of weight reduction on body composition, blood pressure, and serum lipids. The four methods of weight reduction were: 1) diet therapy, 2) diet therapy plus exercise, 3) behavior modification, and 4) behavior modification plus exercise.

Subjects in the diet therapy groups were given guidance in designing their own dietary regimens based on food choices from the "American Dietetic

Association Exchange Lists for Meal Planning" (10). In addition to dietary guidance, subjects in the diet therapy plus exercise group were given assistance in planning supplemental programs of physical activity (equivalent of 250 kcal energy expenditure, daily). Subjects in the behavior modification groups were to lose weight and maintain that loss by developing appropriate eating patterns rather than by following a special, energy-restricted diet. The behavior modification techniques employed were taken from: Habits Not Diets. The Real Way to Weight Control (11). Treatment of subjects in the behavior modification plus exercise group was identical to that of subjects in the behavior modification group except supplemental programs of physical activity (equivalent of 250 kcal energy expenditure, daily) also were included.

## REVIEW OF LITERATURE

Obesity is defined as an excess accumulation of adipose tissue on the body mass. Brozeck et al. (12) have suggested that body fat compose 16 to 19 percent of the total body mass for a normal man and 19 to 23 percent for a normal woman.

### Causes of Obesity

Excess body fat accumulates when a positive energy balance occurs: energy consumed exceeds energy expended. This is usually a result of 1) simple overeating, 2) a metabolic defect, 3) a lack of physical activity, or 4) a combination of those factors.

In a study conducted by Miller and Parsonage (13), 29 women who claimed that they could not lose weight were isolated in a country house and fed 1,500 kcal per day for three weeks. Nine women maintained within  $\pm 1$  kilogram and were characterized by low basal metabolic rates and long previous histories of dieting. The remaining women did lose weight in varying amounts. These findings suggest that among groups of potential dieters, there will be some who have become metabolically adapted to a low energy diet, and others whose inability to lose weight is illusory.

Many controlled studies show significantly reduced physical activity in the obese. Stefanik et al. (14) assessed 14 obese boys and 14 controls at school and during summer camp. He found that the obese boys preferred the less active exercises. A similar study was conducted by Bullen et al. (15) with girls. Motion pictures were taken of obese teenage girls participating in swimming, volleyball and tennis. The pictures showed that the obese girls were less active than non-obese girls even though all the girls spent the same amount



of time at the sport. Mayer (16) has reviewed a number of studies which have shown that obesity is more closely related to inactivity than to energy intake.

#### Diet Therapy as a Means of Weight Reduction

The traditional medical approach to obesity has been diagnosis and referral to a dietician or nutritionist who can provide dietary guidance. The client usually receives excellent advice about the nutritive value of various foods and the proper amounts to include in his prescribed diet. Unfortunately, the client often becomes frustrated with the dietary restrictions imposed upon him and ignores everything he has been taught.

Stunkard and McLaren-Hume (17) and Shipman and Plesset (18) have reported a dropout rate of 20-80 percent for those entering an educational dietary counseling program. Of those individuals remaining in treatment, only 25 percent were able to lose as much as 20 pounds and only 5 percent lost 40 pounds or more. Stunkard (5) also has reported that of 100 consecutive obese out-patients admitted to a nutrition clinic, only 12 percent lost as much as 20 pounds and 28 percent never returned to either the nutrition clinic or the initial referring clinic. Two years after the end of treatment, only two of the initial 100 patients referred to the clinic had maintained their weight loss.

#### Behavior Modification as a Means of Weight Reduction

Studies conducted by Stuart and Davis (19), Stunkard (5), and Levitz (20) support the hypothesis that behavior modification is the most effective way to lose weight permanently. Behavior modification helps the obese person change the habits and behavior patterns associated with the act of obtaining and consuming food.

One can think of all behaviors as determined by its antecedents: those events which take place prior to the occurrence and consequences of a behavior (Figure 1).

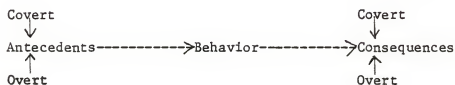


FIG. 1. Schematic representation of the determinants of simple behavior (21).

If the consequences of a behavior are positive (covert: \$5 reward or overt: self-esteem), the probability that the behavior will be repeated increases.

Ferster (22) applied these behavioral concepts to the problem of obesity. He reasoned that if the obese had a learned overweight-eating style that was responsible for their excess weight, then by using stimulus control techniques, which change the antecedents to such behaviors, the therapist should be able to help the client change his eating style and, therefore, reduce weight. For example, if a client experiences a desire to eat a doughnut, in response to an environmental cue or stimulus (walking by the bakery on the way home from work), the first step is to change the environment (taking a different route home), thus decreasing his exposure to a cue that usually provokes an eating response. This approach assumes that all behaviors are learned and maintained through interactions between the individual and relevant persons and situations in his environment.

Stuart (6) was the first to successfully apply the behavioral technology developed experimentally to control various aspects of eating habits. In 1967, he reported the results of his treatment of 10 women. Over a period of one year, two of the ten women dropped out of treatment, 30 percent of the original

sample lost more than 40 pounds and 60 percent lost more than 30 pounds.

The attrition rate is usually lower in behavioral programs than in traditional weight loss programs. Brightwell (23) has suggested that motivation is easier developed in a behavior modification program because the program is in no way restrictive; there is really nothing clients are not allowed to do, only things they must do in addition to their normal daily behavior (eat slowly, keep food out of sight, plan ahead, etc.). Most find this easier to tolerate than rules and regulations which directly restrict dietary intake.

The behavior modification approach to weight control focuses on changing people's eating habits and does not include specific dietary guidance. Ritt et al. (24) conducted a study to learn whether behavior modification techniques result in the adoption of nutritionally sound dietary patterns. Originally, the diets of 15 individuals met two-thirds of all Recommended Dietary Allowances (RDA). After a 20-week behavior modification program, the only nutrients below this level were iron, thiamine, and calcium. Other changes involved an increase in nutrient density (amount of a nutrient found in a food/the number of kcal in the same food x 1,000) for protein, fiber, phosphorous, iron, vitamin A, thiamine, riboflavin, niacin, ascorbic acid and cholesterol. Nutrient density for carbohydrates, fat, and calcium decreased.

#### Physical Activity and Weight Reduction

Traditionally physical activity has been ignored in most weight control programs because of two common misconceptions: 1) exercise plays an insignificant role in total body energy requirements and 2) an increase in physical activity will result in an increased appetite (19).

Physical activity, in fact, is the most variable factor determining the total energy requirement. Inactive individuals may require an energy increase of only 40-50% above their basal needs to satisfy the total energy requirement, whereas very active persons may need increases of 100% or more above basal needs (Figure 2) (19).

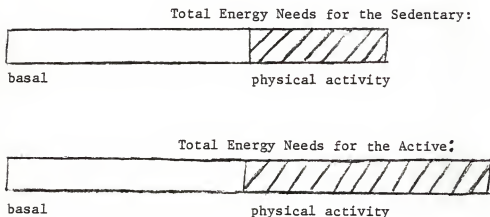


FIG. 2. Diagrammatic representation illustrating the effects of physical activity on total energy needs (19).

Mayer (16) has shown that subjects at a truly sedentary level of activity eat more than those who participate in regular physical activity. Research with both humans and animals suggests that the physiological mechanisms which act to balance food intake with energy expenditure work only within normal ranges of physical activity (16).

#### Weight Reduction and Body Composition

Changes in body weight and body composition of overweight individuals as a result of increased physical activity and decreased energy intake seem to be dependent on the nature and magnitude of the energy deficit (25). In a study conducted by Zutzi and Golding (25), exercise, diet and exercise plus

diet weight reduction programs were used to create an energy deficit. Methods using exercise produced a greater increase in lean body weight, with a greater percentage of fat loss. Treatment by dietary control resulted in a loss of lean body mass. Subjects in the exercise-only group had a slightly greater increase in lean body weight than subjects in the exercise plus diet group.

Keys (26) has found that 98 percent of the weight loss is usually adipose tissue when a diet plus exercise program is employed while only 75 percent of the weight loss is adipose tissue when a diet-only program is followed.

#### Lean Body Weight and Urinary Creatinine Excretion

The precursor of creatinine is creatine which is formed in the liver from three amino acids: arginine, glycine, and methionine. After being discharged in the blood, creatine is absorbed by the body in varying amounts (27). Approximately 98 percent is absorbed by the muscle tissues in the form of creatine-phosphate (28). Creatinine is formed from the hydrolysis of dephosphorylated creatine-phosphate and is excreted in the urine. The fact that creatine is found primarily in muscle tissue, provides the basis for describing urinary creatinine excretion (UCE) as a function of lean body weight.

Forbes and Bruining (29) have reported a very high correlation between LBW as determined by potassium-40 counting and UCE ( $r=.988$ ). The effect of technical error was reduced by averaging the results of two or three  $^{40}\text{K}$  assays on each subject and by making consecutive three-day collections of urine.

Boileau et al. (30), however, have reported lower correlation co-efficients between LBW and UCE ( $r=.73$  before conditioning and  $r=.57$  after conditioning). A large within subject variation was found. Miller and Blyth (31) have reported individuals exhibiting as much as 20 percent variation in daily UCE.

Table 1 shows the relationship of UCE to selected measurements of body composition reported by various authors.

TABLE 1

Relationship of urinary creatinine excretion to selected measurements of body composition reported by various authors (30)

Author	Method	Correlation Coefficient
Miller & Blyth (31)	Body density	.83
Best et al. (32)	Skinfolds	.61
Roessler et al. (33)	40K	.56
Forbes & Bruining (29)	40K	.98
Muldowney et al. (34)	42K dilution	.90
Boileau et al. (30)	Water density	.73 <sup>a</sup> .57 <sup>b</sup>

<sup>a</sup>Before physical conditioning

<sup>b</sup>After physical conditioning

Although the validity of employing UCE to estimate body composition is supported by the significance of its relationship to LBW, the accuracy and consistency with which this method can estimate body composition remains in question (35, 36, 37).

#### Coronary Heart Disease Risk Factors

America is one of the nations with the highest death rates from coronary heart disease (CHD) (38). Certain risk factors for identifying individuals

with a greater propensity for development of CHD have been studied internationally. The most prominent of these risk factors include: elevated serum cholesterol and blood pressure levels and smoking. Obesity, dietary intake, elevated serum triglyceride levels and physical inactivity are recognized as risk factors, but their relative contribution to the development or progression of CHD is less certain (8). The risk of developing CHD is not only proportional to the antecedent level of risk factors but also the risk increases with the number of risk factors involved (9).

### Serum Lipids

In a nine year follow-up of 3,168 men, Carlson et al. (39) have found that the rate of coronary heart disease (CHD) increases linearly with increasing triglyceride (TG) or cholesterol levels. Combined elevation of both lipids carries the highest risk.

Epidemiological studies of various population groups have suggested to many investigators that elevated serum cholesterol is one of the major factors associated with CHD (40). Truett et al. (41) have found that even mildly raised levels of serum cholesterol are considered to be risk factors of ischemic heart disease.

In the Western Collaborative Study, subjects with serum TG levels greater than 176 mg/dl had an annual incidence of CHD over three times that of subjects with levels under 100 mg/dl (42). Carlson (43) and Albrink et al. (44) have reported that serum TG were elevated in 80 percent of men with clinically evident CHD.

In 1975, Miller and Miller (45) postulated a negative correlation between levels of circulating high density lipoprotein and incidence of CHD. This hypothesis has received support from the epidemiological studies of Castelli

et al. (46) (Table 2) and Berg et al. (47). Gordon et al. (48) have reported that women who are obese, diabetic and have low levels of HDL have a very high risk of developing CHD.

TABLE 2

Prevalence of coronary heart disease by high density lipoprotein-cholesterol level, men aged 50-69 (46)

High density lipoprotein level (mg/dl)	Rate/1000
less than 25	180.0
25-34	123.6
35-44	94.6
45-54	77.9
55-64	77.9

The anti-atherogenicity of HDL may be explained by the hypothesis that plasma HDL delivers all of the cholesterol derived from tissues, including the arterial wall, to the liver for catabolism, via the lecithin-cholesterol acyl transferase mechanism (49).

#### Physical Activity and Serum Lipids

Several studies have suggested that physical activity has no significant effect on serum cholesterol (50,51,52). Lewis et al. (53) conducted a study investigating the effects of physical activity on weight reduction in obese women. After 17 weeks of increased physical activity (2.5 miles of jogging and



one hour of calisthenics per week), mean plasma cholesterol concentrations were not significantly changed.

Goode et al. (54) conducted a two-week study in which male subjects were exercised by treadmill to increase energy expenditure by one-sixth. Serum cholesterol levels of the exercisers did not differ significantly with the cholesterol levels of the control subjects, but the serum TG levels were significantly lower.

Other studies also have shown an inverse relationship between levels of physical activity and serum TG concentrations. Garcia-Palmieri et al. (55) reported a correlation of  $-.600$  between serum TG levels and degree of physical activity. Hollosky et al. (51), Hurter et al. (56), and Wood et al. (57) have found fasting plasma TG concentrations to be lower in physically well-trained men than in their sedentary counterparts.

The reduction in serum triglyceride concentrations could be explained by the fact that epinephrine and norepinephrine increase both the lipase activity of adipose tissue (58) and the breakdown of triglyceride in isolated muscle preparations (59) and strenuous exercise is known to increase the discharge of these hormones (60).

High density lipoprotein concentrations have been reported to increase with physical activity (61,53). Lopez et al. (62) have found that after a seven-week program of brief, intense exercise, high density lipoprotein (HDL) increased in medical students. Lehtonen and Viikari (50) have made a positive correlation between the number of kilometers run weekly and the amount of HDL present in the blood. Wood et al. (57) have reported that HDL levels increased in men who did long distance running in their leisure time.

Miller et al. (63) conducted a study in which 27 urban and 25 rural Jamaican men, between the ages of 40 and 76 years, were assessed for body fat,

total serum cholesterol, HDL, low density lipoprotein (LDL), triglyceride, and blood glucose. Rural farmers engaged in manual labor had less body fat, and lower fasting levels of cholesterol, LDL, and triglyceride than urban businessmen. Mean HDL levels were considerably higher for farmers than businessmen. The results of this study imply that physical activity may be beneficial when considering risk factors often associated with greater propensity for coronary heart disease development.

### Body Weight and Serum Lipids

Obesity is often associated with low levels (less than 35 mg/dl) of high density lipoprotein (7). Results from the Framingham Study (48) have suggested that high density lipoprotein (HDL) is correlated negatively ( $r=-.25$ ) with relative weight (actual weight/ideal weight X 100).

As noted earlier, rural Jamaican farmers who were leaner than their sedentary counterparts had considerably higher mean HDL levels, and lower triglyceride, total serum cholesterol, and low density lipoprotein levels (Table 3) (63).

TABLE 3

Plasma lipoprotein lipids and triceps skinfold measurements (63)

Parameters	Urban (n=27) Mean	Rural (n=25) Mean
Cholesterol (mg/dl)	222.0	194.0
High density lipoprotein (mg/dl)	63.0	83.0
Low density lipoprotein (mg/dl)	130.0	94.0
Triglyceride (mg/dl)	146.0	88.0
Tricep skinfold (mm)	11.5	5.2

Kannel et al. (64) have investigated the effects of obesity on serum lipid levels in 5,209 men and women. Results of the Framingham Study suggest that relative weight is correlated with serum cholesterol and triglyceride and inversely correlated with high density lipoprotein cholesterol. In general, relative weight was related more closely to blood lipid levels among men than women of the same age. The strength of that association was greater in younger individuals than older.

Early research, conducted by Walker (65), has suggested that weight reduction can depress elevated serum cholesterol levels. Berkowitz (66) has found that weight reduction improved serum cholesterol concentration in 100 obese men and women, but the specific effects of that improvement were erratic.

#### Blood Pressure and Physical Activity

Lewis et al. (53) conducted a study in which increased physical activity, consisting of jogging two and one-half miles and one hour of calisthenics per week, was the primary focus of a 17-week weight reduction program. Mean resting heart rate and systolic blood pressure were slightly lower at the time of re-evaluation. Heart rate decreased from 65.5 to 62.4 beats per minute, and systolic blood pressure decreased from 116.8 to 112.0 mm/Hg.

Montoye et al. (67) assessed the physical activity patterns of 1,700 adult males. Energy cost was estimated and expressed as a ratio of the work metabolic rate divided by the basal metabolic rate (WMR/BMR). Men were then grouped according to estimated levels of physical activity (highest, intermediate, and lowest). In general, the most active men had the lowest mean systolic and diastolic blood pressures (Table 4).

TABLE 4

Systolic and diastolic blood pressures and physical activity level (67)

Physical activity group	Mean systolic (n) (mm/Hg)		Mean diastolic (n) (mm/Hg)	
Highest	137.3	275	77.9	274
Intermediate	137.9	816	78.5	815
Lowest	140.4	270	80.8	270

Vitale's (68) description of the physiological effects of physical activity on blood pressure would support the findings of Lewis et al. (53). During exercise, collateral circulation between all major arteries is increased and there is better diffusion between the capillaries and the working tissues. The improved blood flow takes an additional work load off the heart. The enlargement and increase in the number of blood vessels decrease resistance to blood flow and lower abnormally high blood pressure, both at rest and during exercise.

#### Blood Pressure and Body Weight

Wilcox (69) has reported that body weight was correlated with systolic ( $r=.42$ ) and diastolic ( $r=.38$ ) blood pressure in 70 massively obese women.

In a study conducted by Montoye et al. (67), approximately 1,700 men (16 to 54 years old) were assessed for systolic and diastolic blood pressure, body fatness (determined by the sum of four skinfolds: triceps, subscapular umbilical and suprailiac), and level of physical activity (determined by the work metabolic rate/basal metabolic rate ratio). Men were grouped according to

level of physical activity (highest, intermediate and lowest). Men who were leaner and more physically active had lower blood pressures than men who were heavier and less active.

The Framingham study (70) has shown that changes in relative weight were paralleled by changes in systolic blood pressure. These changes were small and unrelated to initial relative weight. Changes were less pronounced in women than in men.

#### Dietary Intake and Serum Lipids

Serum cholesterol concentrations in population studies have been correlated with the proportion of dietary kilocalories derived from fat (71). Saturated fats appear to be the main dietary component responsible for this relationship (72).

Nutrient intake in relation to serum triglyceride and cholesterol concentrations has been investigated by Nichols et al. (73). Twenty-four hour dietary recall interviews were conducted among 2,000 men and women in the community of Tecumseh, Michigan. Cholesterol and triglyceride levels were unrelated to quantity, quality, or proportion of fat, carbohydrate or protein consumed. Balart et al. (8) have reported similar findings. Daily dietary intakes of cholesterol and carbohydrate were not correlated with serum cholesterol concentration.

## METHODS AND PROCEDURES

The present study included two weeks of preliminary testing, 12 weeks of experimental treatment, two weeks of post testing, and a three-month follow-up evaluation.

### Subjects

Volunteer subjects were solicited from the community via local newspaper advertisement. Study subjects were premenopausal, non-pregnant, adult women at least 15 pounds overweight according to actuarial statistics for height and weight (74). Approximately 58 women qualified for participation in the study. These subjects were pretested and randomly assigned to one of two experimental groups: 1) diet therapy or 2) behavior modification. These two groups were subdivided into exercise and non-exercise groups.

### Informed Consent Forms

This study was reviewed in accordance with University policy and the United States Department of Health Education and Welfare regulations regarding human subject research. Prior to preliminary testing, each subject was advised of all procedures and methods to be used. A signed consent form (Appendix) was then obtained from each subject.

### Preliminary Testing Period

Subjects were evaluated for the following parameters: 1) selected anthropometric measurements, 2) body composition, 3) urinary creatinine excretion, 4) systolic and diastolic blood pressures, 5) serum lipids (serum

triglycerides, high and low density lipoproteins, total cholesterol, and high density lipoprotein/cholesterol ratio), and 6) three-day dietary food intakes.

#### Anthropometric Measurements and Body Composition

Body density, height, weight, and selected anthropometric measurements were taken in the Exercise Physiology Research Laboratory at Kansas State University, Manhattan, Kansas. Subjects were underwater weighed to determine body density. Body density was converted to percentage fat using the equation devised by Brozek et al. (12):

$$\text{percentage fat} = 100 \times \frac{4.570}{\text{density}} - 4.142$$

Total body fat was calculated by multiplying total body weight by percentage fat. Lean body weight was determined by subtracting total body fat from total body weight. Detailed methods and procedures for this portion of the investigation are discussed in the M.S. thesis by Moyer (1979).

#### Urinary Creatinine Excretion

Each subject collected a complete, 24-hour urine sample in a sealable container containing approximately 10 ml of toluene (a preservative). Urine volume was measured and urinary creatinine excretion was determined by the method of Sieverd (75).

#### Blood Pressure

Systolic and diastolic blood pressures were taken with a stethoscope and sphygmomanometer. Subjects were seated in a chair during blood pressure evaluation.

#### Serum Blood Lipids

Fasting blood samples were taken by venipuncture under medical supervision at Kansas State University, Manhattan, Kansas. The absence of chylomicrons in the electrophoresis pattern together with the standing

turbidity refrigerator test served to indicate that a fasting blood sample had been obtained. Prior to venipuncture, each subject completed a questionnaire pertaining to factors affecting serum lipid levels and incidence of coronary heart disease (Appendix). Blood serum samples were sent to Dr. Manford Morris, Department of Pediatrics, University of Arkansas Medical Sciences, for lipoprotein electrophoresis of triglycerides, high density lipoprotein cholesterol, and total serum cholesterol. Total cholesterol was determined by the method of Rudel et al. (76), triglycerides by the method of Sardesai and Manning (77), agarose electrophoresis by method of Nobel (78), and high density lipoprotein cholesterol by the method of Lopes-Virella (79).

#### Blood Serum Analysis

Blood serums were analyzed by SMA-12 auto-analyzer at the College of Veterinary Medicine, Kansas State University, Manhattan, Kansas. Blood serum constituents analyzed include: glucose, urea, creatinine, calcium, phosphorous, alkaline phosphatase, glutamic pyruvic transaminase, sodium, potassium, carbon dioxide, total protein, albumin, and chloride.

#### Three-day Dietary Intakes

Each subject recorded quantity and type of food eaten for one week (Appendix). From this one-week period, three days were randomly selected to assess dietary intake. Daily nutrient intake was determined as the mean of the three-day dietary assessment. Nutrients assessed include: kilocalories; protein, fat, carbohydrate, fiber, ash, saturated fatty acids, polyunsaturated fatty acids, monosaturated fatty acids (gm/day); sodium, potassium, dietary cholesterol (mg/day); and calcium, iron, vitamin A, ascorbic acid, phosphorous, thiamine, riboflavin, and niacin (percentage of Recommended Dietary Allowances). The DIETETIC COM-PAK program, written by the Department of Nutrition and Dietetics at the University of Missouri



Medical Center, and modified by the Department of Dietetics, Restaurant and Institutional Management, Kansas State University, was used to compute nutrient intake.

Several subjects did not keep complete, accurate records. Quantities of food consumed were often vague ("three handfuls of nuts") or completely omitted ("mashed potatoes and gravy"). Consequently, preliminary three-day dietary intakes were not assessed.

### Experimental Testing Period

Subjects were assigned randomly to one of two experimental groups for 12 weeks: 1) diet therapy or 2) behavior modification. These two groups were subdivided into exercise and non-exercise groups. Women already participating in some form of leisure physical activity were assigned to one of the exercise groups.

During the 12-week experimental period, subjects attended weekly instructional meetings lasting approximately one hour. Subjects were weighed (street clothes, without shoes) on a Homs <sup>2</sup> full-capacity balance beam scale prior to the beginning of each meeting.

Selected presentations were given to all subjects during two of the 12 meetings. Topics discussed include: factors associated with increased risk of coronary heart disease development and factors associated with the origin and propagation of obesity.

During the twelfth week of the experimental treatment period, subjects were instructed to carefully measure and define all food and drinks consumed

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<sup>2</sup>Douglas Homs Corp., Belmont, California.

during the next seven days. From this one-week period, three days were selected randomly to assess dietary intake. Daily nutrient intake was determined as the mean of the three-day dietary assessment.

#### Diet Therapy Group

The goal of the diet therapy group was to lose weight by restricting total energy intake. Individual energy requirements were estimated for each subject based on the energy needs for basal metabolic rate, specific dynamic action, and physical activity. To achieve a weight loss of approximately one pound a week, 500 kcal was subtracted from the estimated total energy needs of each subject (Appendix).

Women in the diet therapy group received the "American Dietetics Association Exchange Lists for Meal Planning" (10). This exchange list provided subjects with a guideline to assist them in designing their dietary regimens which were to be followed throughout the study. The number of food exchanges allowed from each food group was determined by the individual's energy needs. Approximately 20 percent of the total energy allowance was derived from protein, 30 percent from fat, and 50 percent from carbohydrate. (An example 1200 kcal diet is shown in the Appendix.)

A short questionnaire (Appendix) was completed by women in this group six weeks after the beginning of the experimental period. The primary purpose of the questionnaire was to evaluate subject compliance to an energy-reduced, food-exchange diet.

#### Diet Therapy and Exercise Group

In addition to decreasing energy intake by dietary modification, subjects in the diet therapy plus exercise group were instructed to increase energy expenditure by developing individualized programs of physical activity. An exercise physiologist assisted subjects in program planning. During the

last week of the experimental period, each subject kept a physical activity record. MET<sup>3</sup> and energy expenditure (kcal) levels were estimated using tables devised by Fox et al. (80).

#### Behavior Modification Group

Subjects in the behavior modification group were to lose weight and maintain weight loss by developing appropriate eating patterns rather than following a special, restrictive diet. Weekly homework assignments, taken from Ferguson's manual (11), were given to subjects in this group. The purpose of these assignments was to teach subjects to reduce energy intake by modifying their obesity-related behaviors. Assignment topics given include: 1) habit awareness, 2) cue elimination, 3) changing the act of eating, 4) behavior chains and alternate activities, 5) behavioral analysis, progress, and problem solving, 6) pre-planning, 7) cue elimination-II, 8) energy use, 9) snacks, cues, and holidays, and 10) environmental support.

#### Behavior Modification and Exercise Group

Treatment of this group was identical to that of the behavior modification group except physical activity was added to the program as described in the diet therapy and exercise group section.

#### Post Testing Period

A post-testing period of two weeks followed the 12-week experimental treatment period. During this time, all parameters were re-evaluated.

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<sup>3</sup>One MET level is defined as the amount of oxygen consumed during resting metabolism which is equivalent to 3.5 ml O<sub>2</sub>/kg/min.

### Post Experimental Follow-Up

Twelve weeks after completion of the post-testing period, subjects were evaluated for changes in anthropometric measurements and body composition (total body weight, percentage fat, lean body weight, and total body fat).

### Statistical Treatment of the Data

The analysis of variance test (81) was used to determine if any significant differences had occurred among subjects in the four experimental groups between preliminary and post treatment and post treatment and follow-up evaluation. The 0.05 level of probability was selected as the statistical criterion for significance. The paired t-test (81) was used to determine if the mean change or difference from one evaluation period to the next, for subjects within a group, was significant ( $P \leq .05$ ).

## RESULTS AND DISCUSSION

The attrition rate was slightly less for subjects in the two behavior modification groups (41%) than for subjects in the two diet therapy groups (45%). A short questionnaire (Appendix) evaluated subject compliance to an energy reduced, food-exchange diet. Evaluation of completed questionnaires suggested that subjects in the diet therapy groups were not closely following their diets. The average score was 3.5 on a scale from 1 to 5 with 1 representing very good adherence to the diet and 5 representing very poor adherence to the diet. Brightwell (23) has suggested that motivation is more easily developed in behavior modification weight loss programs than in traditional weight loss programs. The results of the present study tend to support Brightwell's observation.

### Body Composition

Mean pre and post treatment and follow-up values for body composition parameters are presented in Table 5. The two series of difference values reflect changes which occurred between pre and post treatment measurement (12-week experimental period) and changes which occurred between post treatment and follow-up (12 weeks) evaluation. Subjects served as their own controls, and so mean differences or changes for each group are based solely on the values of subjects participating in both pre and post treatment tests and post treatment and follow-up measurements. Difference-I values show that only subjects in the behavior modification (BM) group lost a significant ( $P \leq .05$ ) amount of weight (-6.9 pounds). Subjects in the behavior modification plus exercise (BM+EX) group lost 4.0 pounds,

TABLE 5

Pre and post treatment and follow-up values of selected body composition parameters for obese (mean=38% fat) women aged 20-52 years

Parameters	Groups			
	BM+EX <sup>a</sup>	BM <sup>b</sup>	DT+EX <sup>c</sup>	DT <sup>d</sup>
	(n)	(n)	(n)	(n)
Weight (lb)				
Pre	178.4±7.8 <sup>e</sup>	147.0±8.3	137.9±9.6	162.5±8.3
Post	169.7±7.2	141.1±7.7	139.0±9.1	153.0±7.7
Follow-up	170.4±7.6	141.1±7.6	139.0±8.8	161.0±7.6
Difference - I <sup>f</sup>	-4.0	-6.9*	+1.2	-1.7
Difference - II <sup>g</sup>	+0.6	+1.9	-0.4	+1.6
Total body fat (lb)				
Pre	71.2±5.6	55.0±6.0	45.8±8.5	64.4±6.9
Post	64.5±4.8	50.8±5.6	50.5±6.8	52.1±5.6
Follow-up	63.4±7.6	44.7±8.5	52.4±17.0	57.2±12.0
Difference - I	-3.7	-4.9*	+1.1	-1.0
Difference - II	-0.5	+2.8	-0.4	+0.2
Lean body weight (lb)				
Pre	107.2±3.8	91.5±4.1	92.5±5.7	97.9±4.7
Post	105.2±3.9	90.1±4.5	87.2±5.5	96.9±4.5
Follow-up	103.8±6.2	91.4±6.9	94.7±13.9	100.1±9.8
Difference - I	-0.3	-1.4	+0.2	-0.4
Difference - II	+0.3	+1.3	+0.5	+1.8
Percentage body fat				
Pre	39.3±1.8	37.4±1.9	33.1±2.7	39.1±2.2
Post	37.5±1.8	35.8±2.1	36.7±2.6	34.8±2.1
Follow-up	37.1±2.8	32.3±3.1	35.6±6.3	36.5±4.4
Difference - I	-1.2	-1.9*	+0.5	-0.3
Difference - II	+0.1	+0.4	-0.3	-0.2

<sup>a</sup>BM+EX=behavior modification plus exercise.

<sup>b</sup>BM=behavior modification.

<sup>c</sup>DT+EX=diet therapy plus exercise.

<sup>d</sup>DT=diet therapy.

<sup>e</sup>Standard error.

<sup>f</sup>Difference-I represents the change or difference between pre and post measurement values.

<sup>g</sup>Difference-II represents the change or difference between post and 12-week follow up measurement values.

\*Significant at the 0.05 level.

Note: treatment period was 12 weeks in duration.

subjects in the diet therapy plus exercise (DT+EX) group gained 1.2 pounds, and subjects in the diet therapy (DT) group lost 1.7 pounds. Assessment of physical activity records indicated that subjects in the two exercise groups expended approximately 250 kcal, daily, in some form of additional, leisure physical activity. In general, subjects in the two behavior modification groups lost more weight than subjects in the diet therapy groups. Studies conducted by Stuart (6), Stundkard (5), and Levitz (20) also have supported the hypothesis that behavioral approaches to obesity are more successful in terms of weight loss than dietary educational programs.

Difference-II values (Table 5) indicate that no significant changes occurred in body composition between post treatment and follow-up evaluation, however, subjects in the BM+EX group were slightly more successful at maintaining weight loss (+.6 pounds) than subjects in the BM group (+1.9 pounds) and subjects in the DT group (+1.6 pounds). Subjects in the DT+EX group lost some (-.4 pounds) of the weight they had gained over the experimental period. The length of time elapse allowable from post treatment measurement to follow-up evaluation was limited. A two or three year time span between evaluation periods would have been a more interesting and reliable test.

Harris and Hallbauer (82) have conducted a similar 12-week study investigating the effects of diet therapy, behavior modification and exercise on weight reduction. The results of their study indicated that subjects in a behavior modification plus individualized exercise program lost an average of 7.0 pounds while subjects in the behavior modification only program lost 6.0 pounds. The control group, receiving only dietary

counseling, lost just 4.5 pounds. No significant differences occurred between subjects in the three groups. Results of a seven month follow-up showed that subjects in the behavior modification group maintained their previous loss. Subjects in the behavior modification plus exercise group lost two more pounds, and subjects in the control group gained back 7.5 pounds.

In contrast to the study conducted by Harris and Hallbauer (82), subjects in the BM+EX group did not lose more weight than subjects in the BM group over the 12-week experimental period. The reason for this is unknown. Individual motivation, body metabolism, or a combination of these factors may have accounted for some of the differences in group performance. Both studies have suggested that subjects in the behavior modification programs lose more weight than subjects in diet therapy programs, and that exercise facilitates weight loss maintenance.

The data in Table 5 show that only subjects in the BM group lost a significant ( $P \leq .05$ ) amount of total body fat (-4.9 pounds), and percentage fat (-1.9%) between pre and post experimental treatment. Total body weight was correlated positively with total body fat ( $r = .96$ ) and percentage fat ( $r = .89$ ). No significant changes occurred in lean body weight for subjects in any of the four experimental groups. Detailed results of anthropometric and body composition parameters are discussed in the M.S. thesis by Moyer (1979).

#### Urinary Creatinine Excretion

Normal urinary creatinine excretion (UCE) values for adults range from 1-1.8 gm/24 hr (75). In general, mean UCE values (Table 6) for



TABLE 6

Pre and post treatment values of urinary creatinine excretion (UCE) for obese (mean=38% fat) women aged 20-52 years

	Groups							
	BM+EX <sup>a</sup>	(n)	BM <sup>b</sup>	(n)	DT+EX <sup>c</sup>	(n)	DT <sup>d</sup>	(n)
Pre	1.58 $\pm$ .11 <sup>e</sup>	(7)	1.28 $\pm$ .11	(8)	0.98 $\pm$ .12	(6)	1.35 $\pm$ .11	(8)
Post	1.31 $\pm$ .09	(9)	1.20 $\pm$ .11	(6)	1.12 $\pm$ .11	(6)	1.34 $\pm$ .09	(9)
Difference <sup>f</sup>	-0.27g*	(7)	+0.01	(6)	+0.14g	(6)	-0.10	(8)

<sup>a</sup>BM+EX=behavior modification plus exercise. <sup>b</sup>BM=behavior modification. <sup>c</sup>DT+EX=diet therapy plus exercise. <sup>d</sup>DT=diet therapy. <sup>e</sup>Standard error. <sup>f</sup>Difference represents the change or difference between pre and post measurement values. <sup>g</sup>UCE difference values for subjects in these groups are significantly different from one another at the  $P \leq 0.05$  level. \*Significant at the  $P \leq 0.05$  level. Note: treatment period was 12 weeks in duration.

all four groups were within normal limits. Urinary creatinine excretion was significantly ( $P \leq .05$ ) decreased from pre to post treatment evaluation for subjects in the BM+EX group. (Difference values in Table 6 indicate this phenomenon). The change in urinary creatinine excretion for subjects in the BM+EX group ( $-.27$  g/24 hr) was significantly ( $P \leq .05$ ) different from the change in UCE for subjects in the DT+EX group ( $+.14$  g/24 hr). Observation by Srivastava (83) have suggested that urinary creatinine excretion increases following physical activity. This observation would account for the slight increase found in subjects in the DT+EX group, but his work would not substantiate the significant ( $P \leq .05$ ) decrease in urinary creatinine excretion exhibited by subjects in the BM+EX group.

Many investigators (30,31,34) have shown that urinary creatinine excretion is related directly to lean body weight. Correlations ranging from .56 (33) to .98 (29) have been reported. The results of the present study indicated that urinary creatinine excretion was slightly correlated with lean body weight (as determined by water densiometry) before ( $r_{pre} = .58$ ) and after ( $r_{post} = .53$ ) experimental treatment.

The somewhat low correlation and the significant ( $P \leq .05$ ) decrease in UCE by subjects in the BM+EX group may have been the result of incomplete urine collection, UCE variation or a combination of these factors. Forbes and Bruining (29) have reported an average co-efficient variation of 6.9 percent for 34 adults and children. The co-efficient variation was based on three, 24 hour urine collections. The use of UCE to determine body composition of individuals seems to be limited by the likelihood of large within subject variation.

### Serum Lipids

Mean pre and post treatment values for fasting serum triglyceride, cholesterol, low density lipoprotein (LDL)<sup>4</sup>, high density lipoprotein (HDL) and HDL/cholesterol ratio are presented in Table 7.

#### Cholesterol and Triglyceride

The data indicate that initial serum lipid values for subjects in both exercise groups were slightly lower than for subjects in the non-exercise groups. One of the factors considered prior to group assignment was current participation in leisure physical activity. Ideally, occupational as well as leisure physical activity would have been considered in group assignment. Miller et al. (63) also have noted this seemingly beneficial effect of exercise. Jamaican farmers engaged in manual labor as a result of their occupations had lower fasting serum levels than urban businessmen not engaged in occupational physical activity.

The present study indicates that subjects in the BM+EX group significantly ( $P < .05$ ) decreased their cholesterol levels by 17.7 mg/dl. No significant changes occurred for subjects in the other three groups.

Lewis et al. (53) however, have found that physical activity had no effect on cholesterol levels. Twenty-two obese women jogged two and one-half miles and participated in one hour of calisthenics each week for 17 weeks. Mean plasma cholesterol concentrations did not change significantly from the initial to the final evaluation. Lewis et al.'s (53) research supports the response noted for subjects in the DT+EX group.

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<sup>4</sup> LDL was calculated using Fredrickson's formula:  $LDL = \text{total cholesterol} - \text{HDL cholesterol} - \text{triglyceride}/5$ . This formula is only applicable when triglyceride levels are less than 400 mg/dl. All subjects in the present study had levels less than 400 mg/dl.

Table 7  
Pre and post treatment values for fasting serum lipids in obese (mean=38% fat) women aged 20-52 years

Parameters	Groups							
	BM+EX <sup>a</sup>	(n)	BM <sup>b</sup>	(n)	DT+EX <sup>c</sup>	(n)	DT <sup>d</sup>	(n)
Triglyceride (TC-mg/dl)								
Pre	66.9±12.30	(8)	83.8±12.30	(8)	58.9±13.10	(7)	98.0±11.50	(9)
Post	55.9± 8.50	(8)	44.3± 9.80	(6)	59.7± 9.80	(6)	79.0± 8.00	(9)
Difference	-13.4	(7)	-14.7	(6)	+5.2	(6)	-19.0*	(9)
Cholesterol (mg/dl)								
Pre	186.8±10.10	(8)	196.9±10.10	(8)	176.7±10.80	(7)	202.1± 9.50	(9)
Post	168.1±11.40	(8)	192.7±13.10	(6)	182.5±13.10	(6)	200.2±10.70	(9)
Difference	-17.7*	(7)	0.0	(6)	+6.0	(6)	-1.9	(9)
Low density lipoprotein <sup>g</sup> (LDL-mg/dl)								
Pre	125.9± 9.10	(8)	127.4± 9.10	(8)	119.4± 9.80	(7)	138.4± 8.60	(9)
Post	109.6±10.50	(8)	128.6±12.20	(6)	118.2±12.20	(6)	139.0± 9.90	(9)
Difference	-13.9	(7)	-11.6	(6)	-1.0	(6)	-0.6	(9)
High density lipoprotein (HDL-mg/dl)								
Pre	47.5± 3.40 <sup>e</sup>	(8)	52.8± 3.40	(8)	45.6± 3.70	(7)	44.1± 3.20	(9)
Post	47.4± 3.50	(8)	55.2± 4.00	(6)	52.3± 4.00	(6)	45.4± 3.30	(9)
Difference <sup>f</sup>	-1.1	(7)	0.0	(6)	+6.0	(6)	+1.3	(9)
HDL/cholesterol ratio								
Pre	0.26±0.02	(8)	0.27±0.02	(8)	0.26±0.02	(7)	0.22±0.02	(9)
Post	0.29±0.02	(8)	0.29±0.02	(6)	0.29±0.02	(6)	0.23±0.02	(9)
Difference <sup>f</sup>	+0.03*	(7)	-0.01	(6)	+0.02*	(6)	+0.01	(9)

<sup>a</sup>BMT+EX=behavior modification plus exercise. <sup>b</sup>BW=behavior modification. <sup>c</sup>DT+EX=diet therapy plus exercise. <sup>d</sup>DT=diet therapy. <sup>e</sup>Standard error. <sup>f</sup>Difference represents the change or difference between pre and post treatment measurement values. <sup>g</sup>Calculated by Fredrickson et al. (84) formula: LDL = cholesterol - HDL - TG/5. \*Significant at the  $P \leq 0.05$  level. Note: treatment period was 12 weeks in duration.

Mann et al. (85) have reported that decreases in weight have been associated with decreases in serum cholesterol. Berkowiz (66) has shown that weight reduction lowers serum cholesterol, but the specific effects are erratic. Similarly, early studies by Walker (65) have indicated that weight reduction has no significant effect on serum cholesterol unless levels are initially elevated. In the present study, total body weight was not correlated with serum cholesterol. All average group cholesterol levels were less than 220 mg/dl, however, several individual cholesterol values were elevated (Appendix). In a few of these individual cases, cholesterol concentrations decreased with weight reduction (Subject 9010: 167.2 to 164.9 pounds, cholesterol--238 to 155 mg/dl; Subject 9014: 179.8 to 176.8 pounds, cholesterol--234 to 187 mg/dl; Subject 9043: 231.3 to 222.3 pounds, cholesterol--260 to 253 mg/dl).

Kannel et al. (64) have investigated the effects of obesity on serum lipid levels in 5,209 men and women. Results of this study suggest that relative weight is correlated ( $r=.10$ ) with cholesterol concentrations in middle-aged women. In the present study, serum cholesterol levels were not correlated with total body fat mass. The sample size of the present study was very small compared to the population of the Framingham Study. This may have partially accounted for the discrepancy between the two investigations.

The data in Table 7 show that subjects in the DT group significantly ( $P<.05$ ) decreased triglyceride concentration. The reason for this is unknown.

Acquisition of complete, initial dietary intake records would have allowed the assessment of changes in nutrient intake and the effects of those changes on serum cholesterol and triglyceride levels. The present study was limited in this respect.

### High Density and Low Density Lipoprotein (HDL, LDL)

Epidemiological studies have shown that low levels of HDL and high levels of LDL are related directly to coronary heart disease prevalence. Gordon et al. (7) have reported that individuals with HDL levels less than 35 mg/dl have eight times the risk of developing coronary heart disease when compared with individuals having HDL levels greater than 65 mg/dl. The Cooperative Lipoprotein Phenotyping Study (46) has indicated that individuals with LDL levels greater than 130 mg/dl have twice the risk of developing coronary heart disease in comparison to individuals having levels less than 140 mg/dl. Mean HDL and LDL values for subjects in the present study (Table 7) were greater than 35 mg/dl and less than 140 mg/dl, respectively. No significant changes occurred in LDL or HDL concentrations between pre and post treatment evaluation.

The relationship between HDL and physical activity has been studied to some extent by Lopez et al. (62), Enger (61) and Lehtonen and Viikari (50). Increases in physical activity are often associated with increases in HDL-cholesterol. Lewis et al. (53) have investigated the effects of physical activity on weight reduction in 22 obese (mean = 40% fat) middle-aged women. After a 17-week exercise program consisting of 2.5 miles of jogging and one hour of calisthenics per week, mean HDL levels did not change significantly, but the HDL/cholesterol ratio was increased significantly ( $P \leq .05$ ) (pre=.38, post=.43, increase=.05). Similarly, the results of the present study (Table 7) show that HDL values were not altered significantly by experimental treatment, but the HDL/cholesterol ratio was significantly ( $P \leq .05$ ) increased for subjects in the two exercise groups (BM+EX = +.03, DT+EX = +.02).

The inverse relationship of HDL-cholesterol to coronary heart disease is a relatively new approach to assessment of coronary heart disease development. Whether the HDL level is a guide to therapy as well as a risk indicator remains to be determined. The full effects of physical activity, nutrient intake, serum

lipids and body composition on coronary heart disease risk and life expectancy are still unknown. More conclusive research is needed.

#### Blood Pressure

Table 8 summarizes the mean pre and post treatment values for all four experimental groups. Difference values indicate changes which may have occurred between initial and final evaluation. No significant changes were found in either systolic or diastolic blood pressures for subjects in any of the study groups. Diastolic blood pressure was correlated ( $r=.48$ ) with body weight. Wilcox (69) has reported a slightly lower correlation ( $r=.38$ ) in 70 massively obese women (mean age=34 years, mean weight=228 pounds, mean height=65 inches).

#### Blood Serum Analysis

Mean serum constituent values are presented in Table 9. Initial analysis of those values indicated that serum constituents for all subjects were within normal limits.

#### Dietary Intake

The post treatment data in Table 10 indicate that all four experimental groups met two-thirds of the Recommended Dietary Allowances for all nutrients but iron. Subjects in all four groups ingested about 1300 kcal with 20 percent of the energy being derived from protein, 30 percent from fat, and 50 percent from carbohydrate. Even though average energy intakes were not significantly different among subjects in the four groups, the data indicate that subjects in

TABLE 8

Pre and post treatment values for systolic and diastolic blood pressures in obese (mean=38% fat) women aged 20-52 years

Blood pressure	Groups							
	BM+EX <sup>a</sup>	(n)	BM <sup>b</sup>	(n)	DT+EX <sup>c</sup>	(n)	DT <sup>d</sup>	(n)
Systolic blood pressure (mm/Hg)								
Pre	124.5±4.8 <sup>e</sup>	(6)	120.9±4.4	(7)	106.0±5.2	(5)	111.8±4.1	(8)
Post	113.4±3.7	(8)	108.3±4.3	(6)	116.3±3.9	(7)	107.1±3.5	(9)
Difference <sup>f</sup>	-8.3	(6)	-7.6	(5)	+10.8	(5)	-2.5	(8)
Diastolic blood pressure (mm/Hg)								
Pre	85.0±3.3	(6)	75.1±3.1	(7)	68.0±3.6	(5)	76.8±2.9	(8)
Post	77.1±3.1	(8)	72.5±3.4	(6)	71.9±3.2	(7)	75.9±2.8	(9)
Difference	-4.7	(6)	-1.4	(5)	+4.4	(5)	+1.4	(8)

<sup>a</sup>BM+EX=behavior modification plus exercise. <sup>b</sup>BM=behavior modification. <sup>c</sup>DT+EX=diet therapy plus exercise. <sup>d</sup>DT=diet therapy. <sup>e</sup>Standard error. <sup>f</sup>Difference represents the change or difference between pre and post measurement values. Note: treatment period was 12 weeks in duration.



TABLE 9

Pre treatment blood serum constituent values for obese (mean=38% fat) women aged 20-52 years

Constituents	GROUPS			DT <sup>d</sup> (n=9)
	BM+EX <sup>a</sup> (n=8)	BM <sup>b</sup> (n=8)	DT+EX <sup>c</sup> (n=7)	
Glucose (mg/dl)	81.5±1.60 <sup>e</sup>	74.6±2.71	77.7±1.73	77.3±2.99
Urea (mg/dl)	12.7±1.20	13.8±1.01	11.4±1.19	13.3±0.84
Creatinine (mg/dl)	0.8±0.03	0.8±0.03	0.8±0.02	0.8±0.03
Calcium (mg/dl)	8.5±0.09	8.5±0.14	8.7±0.11	8.7±0.11
Phosphorous (mg/dl)	3.6±0.08	3.7±0.11	3.7±0.13	3.6±0.14
Alkaline phosphatase (I.U.)	68.6±5.34	65.3±3.75	61.4±7.04	69.3±9.81
Glutamic pyruvic transaminase	14.4±3.27	11.6±1.28	11.9±1.29	17.1±3.76
Sodium (mEq/L)	138.1±0.47	139.0±0.65	138.6±0.37	139.1±0.75
Potassium (mEq/L)	4.4±0.20	4.9±0.18	4.6±0.17	4.6±0.10
Carbon dioxide (mM/L)	27.9±1.01	26.1±0.72	26.6±0.92	26.8±1.18
Total protein (mg/dl)	6.9±0.15	7.0±0.07	6.9±0.16	7.1±0.15
Albumin (gm/dl)	4.2±0.12	4.3±0.05	4.2±0.10	4.3±0.07
Chloride (mEq/L)	106.0±0.94	105.6±0.56	106.9±1.52	105.7±0.69

<sup>a</sup>BM+EX=behavior modification plus exercise.<sup>b</sup>BM=behavior modification.<sup>c</sup>DT+EX=diet therapy plus exercise.<sup>d</sup>DT=diet therapy. <sup>e</sup>Standard error.

TABLE 10  
Post treatment values of nutrient intake for obese (mean = 38% fat) women aged 20-52 years

Nutrient (daily intake)	Groups			
	BM+EX <sup>a</sup> (n=9)	BM <sup>b</sup> (n=8)	DT+EX <sup>c</sup> (n=7)	DT <sup>d</sup> (n=9)
Kilocalories	1506±143.3 <sup>e</sup>	1165±143.3	1344±143.3	1305±134.4
Protein (gm)	72± 5.3	55± 5.3	50± 5.3	58± 4.9
Fat (gm)	73± 8.1	42± 8.1	55± 8.1	56± 7.5
Carbohydrate (gm)	135± 20.0	145± 20.0	163± 20.0	146± 18.7
Fiber (gm)	2± 0.4	2± 0.4	2± 0.4	2± 0.4
Calcium (% of RDA)	77± 12.6	51± 12.6	61± 12.6	82± 11.8
Phosphorous (% of RDA)	120± 11.4	96± 11.4	99± 11.4	109± 10.6
Iron (% of RDA)	56± 6.9	57± 6.9	46± 6.9	47± 6.4
Sodium (mg)	2511±302.9	1510±302.9	2207±302.9	1806±283.3
Potassium (mg)	1513±158.2	1324±158.2	1531±158.2	1415±148.0
Vitamin A (% of RDA)	111± 23.2	81± 23.2	69± 23.2	78± 21.7
Thiamine (% of RDA)	79± 9.9	68± 9.9	71± 9.9	74± 9.2
Riboflavin (% of RDA)	98± 12.2	89± 12.2	69± 12.2	83± 11.4
Niacin (% of RDA)	98± 11.1	92± 11.1	75± 11.1	82± 10.5
Ascorbic acid (% of RDA)	139± 31.1	150± 38.1	145± 38.1	147± 35.6
SFA <sup>f</sup> (gm)	17± 2.4	8± 2.4	15± 2.4	15± 2.3
UFA <sup>g</sup> (gm)	20± 2.7	10± 2.7	14± 2.7	15± 2.5
PUFA <sup>h</sup> (gm)	10± 2.1	4± 2.1	7± 2.1	6± 2.0
Dietary cholesterol (gm)	340± 65.5	242± 65.5	175± 65.5	251± 61.3

<sup>a</sup>BM+EX=behavior modification plus exercise. <sup>b</sup>BM=behavior modification. <sup>c</sup>DT+EX=diet therapy plus exercise. <sup>d</sup>DT=diet therapy. <sup>e</sup>Standard error. <sup>f</sup>SFA=saturated fatty acids. <sup>g</sup>UFA=monounsaturated fatty acids. <sup>h</sup>PUFA=polyunsaturated fatty acids.

the BM group consumed the least amount of energy (1,165 kcal) and lost the greatest amount of weight (-6.9 pounds). Subjects in the two behavior modification groups adopted nutritionally sound dietary patterns without specific dietary guidance. Ritt et al. (24) have reported similar results.

This study was primarily limited by subject compliance. Individual motivation, sincerity, honesty and willingness to participate greatly influenced the outcome of the study. Because of the insignificant change in weight by subjects in the diet therapy groups and the poor adherence to dietary regimens, daily energy intakes may have been higher than mean values indicate.

Serum cholesterol concentrations in population studies have been correlated with the proportion of energy derived from fat (71). Saturated fats appear to be the dietary component responsible for this relationship (72). Nutrient intake in relation to serum triglyceride and cholesterol levels have been investigated by Nichols et al. (73). Twenty-four hour dietary recall interviews were conducted among 2,000 men and women in the community of Tecumseh, Michigan. Serum lipid levels were unrelated to quantity, quality or proportion of fat, carbohydrate or protein consumed. Similarly, in the present study, no correlations were found between serum lipid levels and carbohydrate, fat, protein or cholesterol intakes.

## SUMMARY AND CONCLUSIONS

The present study was conducted to investigate the effects of diet therapy, behavior modification, and exercise on weight reduction, body composition, serum lipids, and blood pressure. Following are the four experimental groups: 1) behavior modification plus exercise (BM+EX), 2) behavior modification (BM), 3) diet therapy plus exercise (DT+EX), and 4) diet therapy (DT).

The success of the weight reduction treatments was measured by the attrition rate and the total weight loss for the 12-week period. Lean body weight loss was considered undesirable. The attrition rate for subjects in the two behavior modification groups was slightly less than the attrition rate for subjects in the two diet therapy groups. Subjects in the two diet therapy groups indicated fair to poor adherence to their respective diets. Subjects in the BM group lost a significant ( $P < .05$ ) amount of weight (-6.9 pounds) while weight loss was not significant for subjects in the other three groups (BM+EX: -4.0 pounds; DT+EX: +1.2 pounds; DT: -1.7 pounds).

A significant ( $P < .05$ ) reduction in total body fat (-4.9 pounds), and percentage fat (-1.9 percent), as determined by water densitometry, was noted for subjects in the BM group. Total body weight was correlated with total body fat ( $r = .96$ ) and percentage fat ( $r = .89$ ). No significant changes in lean body weight occurred for subjects in any of the four experimental groups. A 12-week follow-up evaluation indicated that weight and body composition parameters were not significantly changed from post to follow-up evaluation.

Mean urinary creatinine excretion values for subjects in the BM+EX group decreased significantly ( $P < .05$ ) from pre to post treatment evaluation

(- .27 g/24 hr), and the change in urinary creatinine excretion values for members of this group was significantly ( $P \leq .05$ ) different from the change in urinary creatinine excretion values for subjects in the DT+EX group (+.14 g/24 hr). In general, mean values for all groups were within normal limits. Lean body weight was slightly correlated ( $r_{\text{pre}} = .58$ ,  $r_{\text{post}} = .53$ ) with urinary creatinine excretion.

Subjects in the BM+EX group significantly ( $P \leq .05$ ) decreased serum cholesterol levels (-17.7 mg/dl) from pre to post treatment evaluation. A significant ( $P \leq .05$ ) decrease in serum triglyceride was noted for subjects in the DT group. Low density lipoprotein and high density lipoprotein (HDL) serum lipids were not significantly changed for subjects in any of the four groups, however, the HDL/cholesterol ratio was significantly ( $P \leq .05$ ) increased for subjects in the two exercise groups (BM+EX: +.03; DT+EX: +.02).

No significant changes were found in either systolic or diastolic blood pressures for subjects in any of the experimental groups. Diastolic blood pressure was correlated ( $r = .48$ ) with total body weight.

Selected blood serum constituents were within normal limits for all subjects.

Average energy intakes were not significantly different among subjects in the four experimental groups, however, subjects in the BM group consumed the least amount of energy (1,165 kcal) and lost the most weight (-6.9 pounds). Twenty percent of the total energy consumed by subjects in all four groups was derived from protein, 30 percent from fat, and 50 percent from carbohydrate. Subjects in all experimental groups met two-thirds or more of the Recommended Dietary Allowances for all nutrients but iron. No correlation was found between serum lipid levels and carbohydrate, fat, protein, or cholesterol intake.

Based on the results of the present investigation, the following conclusions have been made. Motivated individuals, utilizing a balanced food-exchange diet for weight reduction, can lose weight and maintain good nutritional status, however, motivation is not easily maintained in this kind of program. In contrast, motivation is more easily developed in a behavior modification program which attempts to change the consequences of an individual's behavior by reducing the number of antecedents that lead to inappropriate eating behavior. Secondly, daily physical activity representing a 250 kcal energy expenditure may reduce serum cholesterol and increase the high density lipoprotein/cholesterol ratio.

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## APPENDIX

I \_\_\_\_\_ have volunteered to participate in an experiment designed to study the effectiveness of different methods of weight control. I have been asked to complete the study which will conclude Dec. 15, 1978, but I should feel free to withdraw at any time. A follow-up test will be done in March of 1979 if I can participate. I understand that I may refuse to undergo any of the testing procedures without prejudice.

Participation will require the following physical measurements and tests:

- (1) Body weight--taken initially and on a weekly basis
- (2) Body height--taken initially
- (3) Skinfolts--taken initially, at the midpoint, and end
- (4) Underwater weighing--taken initially, at the midpoint, and end. (Weighing will be done while in a swimming suit.)
- (5) Bone diameters and girth measurements will be taken initially
- (6) Blood pressure--initial, midpoint, and final
- (7) Three day dietary food records will be obtained three times during the study
- (8) A 24-hour urine collection--taken initially, at the midpoint and final stages of testing
- (9) Fasting blood will be obtained by veinipuncture at the beginning and end of the study period. This will be done under the supervision of medical or allied health personnel.

All final testing will be done before the end of the 1978 school semester. A follow-up test will be planned for March 1979, using the same testing procedures as above.

I will be required to attend 12 weekly instructional and educational meetings, lasting from 30 to 60 minutes.

I will feel free to ask questions about testing procedures. All results will be kept strictly confidential. I will have an opportunity at the end of the study to find out the conclusions.

To my knowledge, I am in a good state of health. I am not pregnant and do not have any cardiovascular problem, infectious disease or metabolic condition which could limit my participation in the study. If pregnancy occurs, I will voluntarily withdraw from the study.

I have read and understand the above statement. I hereby voluntarily consent to participate.

Date \_\_\_\_\_

Signature \_\_\_\_\_

Witness \_\_\_\_\_

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## BLOOD LIPID SURVEY

Name \_\_\_\_\_ Local Physician \_\_\_\_\_

Telephone Number \_\_\_\_\_

Height \_\_\_\_\_

Weight \_\_\_\_\_

Age \_\_\_\_\_ Date Form Completed \_\_\_\_\_

1. Are you now on diet therapy for hyperlipidemia or a low cholesterol diet? Yes \_\_\_ No \_\_\_

2. Have you ever been advised by your physician to eat a low cholesterol diet? Yes \_\_\_ No \_\_\_

3. Are you taking drugs for hyperlipidemia? Yes \_\_\_ No \_\_\_

If yes indicate drug and dosage

a) clofibrate (Atromid-S) \_\_\_\_\_

b) thyroxine \_\_\_\_\_

c) nicotinic acid \_\_\_\_\_

d) cholestyramine \_\_\_\_\_

e) other \_\_\_\_\_

4. Are you taking oral contraceptives? Yes \_\_\_ No \_\_\_

If yes indicate type (name) \_\_\_\_\_

5. Are you taking any androgenic steroid? Yes \_\_\_ No \_\_\_

If yes indicate drug and dosage

a) fluoxymesterone \_\_\_\_\_

b) oxymethalone \_\_\_\_\_

c) norandrolone \_\_\_\_\_

d) testosterone \_\_\_\_\_

e) other \_\_\_\_\_

6. Do you smoke? Yes \_\_\_ No \_\_\_

If yes, please indicate

cigarettes \_\_\_\_\_ packs/day \_\_\_\_\_

cigars \_\_\_\_\_

pipe \_\_\_\_\_



7. Have you ever taken any medicine for heart trouble Yes \_\_\_ No \_\_\_  
 If yes, type \_\_\_\_\_  
 Do you take it now? Yes \_\_\_ No \_\_\_
8. Have you ever been told that you have high blood pressure? Yes \_\_\_ No \_\_\_  
 If yes, what was your age \_\_\_\_\_
9. Have you ever taken any medicine for high blood pressure? Yes \_\_\_ No \_\_\_  
 If yes, when? \_\_\_\_\_  
 For how long \_\_\_\_\_  
 Do you take it now Yes \_\_\_ No \_\_\_
10. Have you ever had a heart attack? Yes \_\_\_ No \_\_\_  
 If yes, at what age? \_\_\_\_\_
11. Is your mother alive? Yes \_\_\_ No \_\_\_  
 If yes, a) age now \_\_\_\_\_  
 b) Has she ever been thought to have heart disease?  
 Yes (describe) \_\_\_\_\_ No \_\_\_\_\_  
 If no, a) cause of death? \_\_\_\_\_  
 b) age at death \_\_\_\_\_
12. Is your father alive? Yes \_\_\_ No \_\_\_  
 If yes, a) age now \_\_\_\_\_  
 b) Has he ever been thought to have heart disease?  
 Yes (describe) \_\_\_\_\_ No \_\_\_\_\_  
 If no, a) cause of death? \_\_\_\_\_  
 b) age at death \_\_\_\_\_
13. How many brothers and sisters have you who are alive now?  
 Brothers? \_\_\_\_\_ Ages? \_\_\_\_\_  
 Sisters? \_\_\_\_\_ Ages? \_\_\_\_\_
14. Have any of them ever had heart trouble? Yes \_\_\_ No \_\_\_  
 not applicable \_\_\_\_\_  
 If yes, give details as follows
- |    | <u>Brother or Sister</u> | <u>Age when trouble started</u> | <u>Nature of Illness</u> |
|----|--------------------------|---------------------------------|--------------------------|
| a) | _____                    | _____                           | _____                    |
| b) | _____                    | _____                           | _____                    |
| c) | _____                    | _____                           | _____                    |
| d) | _____                    | _____                           | _____                    |

15. Have you ever had blood drawn for a test for cholesterol, triglycerides or lipoproteins (fats)? Yes \_\_\_\_ No \_\_\_\_

If yes, please record the known values

cholesterol \_\_\_\_\_ date \_\_\_\_\_

triglycerides \_\_\_\_\_

lipoproteins \_\_\_\_\_

16. Have your children had blood drawn for a test of cholesterol, triglycerides or lipoproteins? Yes \_\_\_\_ No \_\_\_\_

Not known \_\_\_\_\_

If yes, please record the known values

	<u>Son</u>	<u>Daughter</u>	<u>Age</u>
cholesterol	_____	_____	_____
triglyceride	_____	_____	_____
lipoproteins	_____	_____	_____

17. Has anyone in your family ever had diabetes (sugar disease)? Yes \_\_\_\_ No \_\_\_\_

If yes, which of your relatives (e.g. brother, cousin, parent) \_\_\_\_\_

18. If you are married, does your spouse suffer from

a) heart trouble Yes \_\_\_\_\_ No \_\_\_\_\_

b) high blood pressure Yes \_\_\_\_\_ No \_\_\_\_\_

19. What medications are you presently taking?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Please do not write below this line.

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

Serum cholesterol mg/dl: \_\_\_\_\_

Serum triglyceride mg/dl: \_\_\_\_\_

Lipoprotein electrophoresis:

Check one

Normal \_\_\_\_\_

Type I \_\_\_\_\_

Type II \_\_\_\_\_

Type III \_\_\_\_\_

Type IV \_\_\_\_\_

Type V \_\_\_\_\_

Chylomicrons present

Yes \_\_\_\_\_

No \_\_\_\_\_

Other abnormality (specify)

## DIETARY RECORD

57

Name \_\_\_\_\_ Date \_\_\_\_\_ Day \_\_\_\_\_  
Place eaten: \_\_\_\_\_ Dinner \_\_\_\_\_ Supper \_\_\_\_\_  
Breakfast \_\_\_\_\_ Lunch \_\_\_\_\_ Dinner \_\_\_\_\_

Food	Estimated measure	Kind of ingredients
Breakfast		
Between Meals		
Lunch or Dinner		
Between Meals		
Dinner or Supper		
Between Meals		

# CALCULATION OF DAILY ENERGY REQUIREMENTS<sup>5</sup>

## 1. Energy expenditure for basal metabolic rate (BMR)

(A) \_\_\_\_\_ (weight in kg) x 1 kcal = (B) \_\_\_\_\_

To find the daily expenditure for BMR, multiply (B) by 24 hours.

(B) \_\_\_\_\_ x 24 hr = (c) \_\_\_\_\_

## 2. Energy expenditure for activity

Sedentary	20% of BMR
Light activity	30% of BMR
Moderate activity	40% of BMR
Heavy activity	50% of BMR

Select the appropriate activity level and calculate the number of kcal you denote to activity

\_\_\_\_\_ % of (C) \_\_\_\_\_ = (D) \_\_\_\_\_

## 3. Energy expenditure for specific dynamic action (SDA)

Estimation of SDA

10% of [(C) \_\_\_\_\_ + (D) \_\_\_\_\_] = (E) \_\_\_\_\_

## 4. Total daily energy expenditure

(C) \_\_\_\_\_ + (D) \_\_\_\_\_ + (E) \_\_\_\_\_ = TOTAL \_\_\_\_\_

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<sup>5</sup>Williams, S.R. Nutrition and Diet Therapy. (2nd ed.). St. Louis: C.V. Mosby Co., 1973, p. 484.

## 1,200 KILOCALORIE DAILY FOOD PLAN

6 meat exchanges  
 4 bread exchanges  
 2 milk exchanges  
 3 vegetable exchanges  
 3 fruit exchanges  
 3 fat exchanges

Breakfast:	1 oz. toast	1 bread
	1 tsp. margarine	1 fat
	1 orange	1 fruit
	1/3 C. cottage cheese	1 meat
	coffee	
Lunch:	chicken sandwich:	
	(2 slices bread	2 bread
	2 oz. chicken	2 meat
	1 tsp. mayonaise)	1 fat
	cucumber slices	1 vegetable
	carrot sticks	1 vegetable
	3/4 C. plain yogurt	1 milk
	1/2 C. strawberries	1/2 fruit
	ice tea	
Dinner:	3 oz. broiled lean beef	3 meat
	baked potato	1 bread
	1 T. sour cream	1 fat
	broccoli spears	1 vegetable
	apple sliced on	1 fruit
	lettuce leaf	
	coffee	
Snack:	banana milk shake	
	(1/4 banana	1/2 fruit
	1 C. skim milk	1 milk
	artificial sweetner)	

QUESTIONNAIRE EVALUATING SUBJECT COMPLIANCE TO  
AN ENERGY-RESTRICTED FOOD EXCHANGE DIET

1. On a scale from 1 to 5, with 1 representing very good adherence and 5 representing very poor adherence, please indicate how closely you've been following your diet. \_\_\_\_\_

2. When are you most likely to be tempted not to follow your diet? Please check the appropriate answer.

\_\_\_\_\_ morning

\_\_\_\_\_ afternoon

\_\_\_\_\_ evening

3. Is it more difficult to follow your diet when you are alone or with others?

\_\_\_\_\_

4. Please list two of your favorite foods. Have you included them in your diet plan?

\_\_\_\_\_

## INDIVIDUAL SUBJECT VALUES

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride <sup>a</sup>	Cholesterol <sup>a</sup>	HDL <sup>a</sup>	LDL <sup>a</sup>	HDL/cho1
9004	1 <sup>b</sup>	42	58.5	176* 175**	41.8 40.2	36 30	150 146	53 52	90 88	.35 .36
9007	1	31	63.3	144 134	36.2 32.8	47 22	196 156	75 43	112 109	.38 .28
9008	1	47	65.0	156 163	38.0 40.6	86 68	170 162	45 54	108 94	.26 .33
9010	1	34	64.0	167 165	37.8 37.0	193 88	238 155	50 40	125 91	.21 .26
9011	1	39	70.0	223 211	43.5 40.4	44 35	171 127	39 53	123 67	.23 .42
9013	1	34	65.4	142 139	30.4 29.9	98 54	179 180	44 42	115 127	.25 .23
9039	1	30	66.0	216 ---	44.0 ---	--- 66	--- 166	-- 47	--- 106	--- .28
9043	1	31	69.0	231 222	42.8 41.7	89 84	260 253	47 48	195 188	.18 .19
9051	1	46	67.0	150 149	38.8 37.0	60 ---	191 ---	40 --	139 ---	.21 ---

<sup>a</sup> Serum lipid measurement units = (mg/dl).  
measurement. \*\*=post treatment measurement.

<sup>b</sup> 1=behavior modification plus exercise. \*pre treatment



Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride <sup>a</sup>	Cholesterol <sup>a</sup>	HDL <sup>a</sup>	LDL <sup>a</sup>	HDL/chole
9001	2 <sup>b</sup>	35	62.0	141* 142**	36.2 37.6	57 43	195 207	49 49	135 149	.25 .24
9009	2	22	63.0	128 121	38.3 35.1	30 37	192 208	63 65	123 136	.33 .31
9018	2	33	66.6	164 142	34.4 28.3	55 36	163 198	46 31	106 160	.28 .16
9028	2	51	62.0	168 156	41.4 39.7	123 ---	233 ---	41 --	167 ---	.18 ---
9034	2	20	61.5	140 ---	35.6 ---	193 ---	238 ---	50 --	149 ---	.21 --
9040	2	42	63.9	151 151	46.2 45.3	119 77	194 193	75 79	95 98	.39 .41
9047	2	31	64.0	135 135	29.5 28.8	45 39	177 169	40 45	128 116	.23 .27
9053	2	38	64.3	148 142	37.5 ---	48 34	183 181	58 62	115 112	.32 .34

<sup>a</sup> Serum lipid measurement units = (mg/dl). <sup>b</sup> I=behavior modification. \*pre treatment measurement.  
 \*\*post treatment measurement.

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride <sup>a</sup>	Cholesterol <sup>a</sup>	HDL <sup>a</sup>	LDL <sup>a</sup>	HDL/chole
9026	3 <sup>b</sup>	43	60.0	132* 133**	--- 40.3	61 39	211 204	42 54	157 142	.20 .26
9030	3	35	65.1	146 147	36.2 35.9	43 86	172 204	50 60	113 127	.29 .29
9036	3	20	64.0	139 ---	27.2 ---	31 54	141 153	39 45	96 97	.28 .29
9042	3	38	61.0	127 128	35.3 35.3	49 42	184 187	50 63	124 116	.27 .34
9048	3	35	66.5	142 144	33.7 35.4	85 ---	178 ---	41 ---	120 ---	.23 ---
9052	3	21	63.0	142 ---	--- ---	46 34	170 137	47 42	114 88	.28 .31
9054	3	20	63.0	--- 146	--- ---	97 103	181 210	50 50	112 139	.28 .24

<sup>a</sup>Serum lipid measurement units = (mg/dl).

\*\*=post treatment measurement.

<sup>b</sup><sub>3</sub>=diet therapy plus exercise.

\*=pre treatment measurement.

Subject	Group	Age	Height (in)	Weight (lb)	Percentage fat	Triglyceride <sup>a</sup>	Cholesterol <sup>a</sup>	HDL <sup>a</sup>	LDL <sup>a</sup>	HDL/chol
9003	4 <sup>b</sup>	27	146	---* ---**	---	72 55	172 202	43 43	115 148	.25 .21
9006	4	35	65.0	144 146	33.8 33.9	62 68	210 209	46 48	152 147	.22 .23
9014	4	31	65.0	180 177	---	116 54	234 187	54 55	157 121	.23 .29
9023	4	41	61.0	144 144	37.3 37.0	103 69	230 249	43 48	166 187	.19 .19
9024	4	45	62.9	166 161	37.7 37.0	103 104	233 255	43 50	169 184	.18 .19
9041	4	49	63.0	154 154	43.9 44.2	128 122	221 207	48 50	147 133	.22 .24
9045	4	31	67.0	162 157	30.4 29.4	78 55	203 182	54 47	133 124	.27 .26
9046	4	29	60.0	206 ---	51.1 ---	126 93	153 146	35 32	93 95	.23 .22
9056	4	26	64.0	--- 132	--- 27.4	94 92	163 165	31 36	113 111	.19 .22

<sup>a</sup> Serum lipid measurement units = (mg/dl). <sup>b</sup> 4=diet therapy. \*pre treatment measurement. \*\*=post treatment measurement.

THE EFFECTS OF DIET THERAPY, BEHAVIOR MODIFICATION, AND  
EXERCISE ON WEIGHT REDUCTION AND SERUM LIPIDS

by

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AN ABSTRACT OF A MASTER'S THESIS

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MASTER OF SCIENCE

Department of Foods and Nutrition

KANSAS STATE UNIVERSITY  
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Thirty-three premenopausal, non-pregnant, obese (mean = 38% fat) women aged 20 to 52 years were participants in a 12-week study designed to investigate the effectiveness of two methods of weight reduction and the effects of diet therapy, behavior modification, and exercise on weight reduction, body composition, urinary creatinine excretion, blood pressure, serum lipids, and nutritional status. Women were assigned randomly to one of two groups: 1) behavior modification(BM) or 2) diet therapy (DT). These two groups were subdivided into exercise and non-exercise groups. Subjects who were presently participating in some form of physical activity were assigned to one of the exercise groups. Women in the behavior modification groups were to lose weight by developing appropriate eating patterns rather than by following a special, restrictive diet. Women in the diet therapy groups were to lose approximately one pound, weekly, by following their individualized energy-restricted diets. Exercise consisted of increased physical activity (equivalent of about 250 kcal energy expenditure). Subjects were tested before and after the 12-week experimental period. A follow-up study was conducted 12 weeks later.

The attrition rate for subjects in the two behavior modification groups was slightly less than for subjects in the diet therapy groups (41% versus 45%). Only subjects in the BM group lost a significant ( $P \leq .05$ ) amount of weight (-6.9 pounds), total body fat (-4.9 pounds), and percentage fat (-1.9%) between pre and post treatment evaluation. Total body weight was correlated with total body fat ( $r=.96$ ) and percentage fat ( $r=.89$ ). No significant changes in lean body weight occurred for subjects in any of the four groups. A 12-week follow-up study indicated that body composition did not change significantly from post treatment to follow-up investigation. Mean urinary creatinine values for subjects in the BM+EX group decreased significantly ( $P \leq .05$ )

and the changes in urinary creatinine excretion (UCE) for members of this group were significantly ( $P \leq .05$ ) different from the changes in UCE for subjects in the DT+EX group. Lean body weight was slightly correlated ( $r_{pre} = .58$ ;  $r_{post} = .53$ ) with UCE. Subjects in the BM+EX group significantly ( $P \leq .05$ ) decreased serum cholesterol levels by 17.7 mg/dl. A significant ( $P \leq .05$ ) decrease in serum triglyceride ( $-19.0$  mg/dl) was noted for subjects in the DT group. Low density lipoprotein and high density lipoprotein (HDL) were not significantly changed from pre to post treatment evaluation, but the HDL/cholesterol ratio was significantly ( $P \leq .05$ ) increased for subjects in the two exercise groups. No significant changes were found in systolic or diastolic blood pressure. Diastolic blood pressure was slightly correlated ( $r = .48$ ) with total body weight. Mean energy intakes were not significantly different among subjects in the four groups, however, subjects in the BM group consumed the least amount of energy (1,165 kcal) and lost the most weight ( $-6.9$  pounds). Subjects met two-thirds of the Recommended Dietary Allowances for all nutrients but iron. Serum blood lipids were not correlated with fat, carbohydrate, or dietary cholesterol intake. Subjects in the DT group indicated fair to poor adherence to their respective diets.

The results of the present study suggest that motivation is more easily developed in a behavior modification program than an energy-restricted dietary program. Increased daily physical activity (equivalent of 250 kcal energy expenditure) may reduce cholesterol levels and increase the HDL/cholesterol ratio.